PATENT SPECIFICATION

769,818

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COMPLETE SPECIFICATION

Processes and apparatus for the catalytic cracking of hydrocarbon oiis.

We, N. V. DE BATAAFSCHE PETROLEUM MAATSCHAPPIJ, a company organised under the laws of The Netherlands, of 30, Carel van Bylandtlaan, The Hague, The Netherlands, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement.

This invention relates to improved processes for the cracking of hydrocarbon oils using fluidised catalysts and also to apparatus for carrying out such processes.

It is known that in the catalytic cracking of hydrocarbon oils carbonaceous deposits are formed on the catalyst, as a result of which deposits the activity of the catalyst, gradually decreases. In order to restore the activity of the catalyst, spent catalyst is passed continuously from the reaction space to a regenerator in which the carbonaceous deposits are burnt from the catalyst by the treatment thereof with an oxygen-containing gas at high temperature, after which treatment the regenerated catalyst can be used again. Before beginning this regeneration, it is usual to treat the catalyst which passes from the reaction zone with steam or another gaseous stripping agent in order to remove valuable evaporable hydrocarbons which have been adsorbed by the catalyst and entrained in its flow, which hydrocarbons would otherwise be lost by combustion in the regenerator.

The stripping operation constitutes a very important part of such cracking processes and can be effected in a stripper which is situated in the reactor or in a separate stripper connected between the reactor and the regenerator, the vapours issuing from the stripper usually being mixed with the vapours from the reactor and these mixed vapours being then further processed together.

Throughout this specification and the claims hereinafter appearing, the expression " a process of the kind hereinbefore described " designates a process for the catalytic cracking of a hydrocarbon oil by means of fluidised catalyst, wherein the catalyst is cycled through a reactor, a stripper and a regenerator, the gases and vapours from the stripper are mixed with those issuing from the reactor, the catalyst issuing from the reactor is passed via a riser and by means of a stripping agent into the stripper, and the pressure of the gas phase in the stripper is so regulated by means of a control valve in the line which connects the gas phase in the stripper with the gas phase above the catalyst bed in the reactor that conditions for the flow of catalyst from the stripper to the regenerator remain constant or practically constant.

The Applicant's Patent Specification No. 718,578, discloses a process of the kind hereinbefore described wherein the catalyst which is withdrawn from the reactor is brought via a riser into a separate stripper by means of steam. The stripped catalyst flows from this separate stripper to the regenerator through a standpipe provided with a control valve, the conditions for this flow being kept constant by regulation of the pressure of the gas phase with that above the catalyst bed in the reactor.

In this process, stripping of the catalyst occurs chiefly in the riser via which the catalyst is passed from the reactor in a dispersed phase to the stripper, which is far more effective than the conventional stripping operation wherein the stripping agent is passed through a fluidised bed of the catalyst to be stripped. By using the last mentioned control valve, by which the vapour pressure and thus the catalyst level is kept constant in the stripper in case there should be a change in the vapour pressure in the reactor, a slide valve is rendered superfluous in the standpipe through which the catalyst flows out of the reactor into the riser, via which it passed to the stripper by means of a stripping agent.

(Price 3/-.)

Nevertheless, in order to ensure a positive control of the catalyst flow in the catalyst recycling system, two side valves are required, viz one in the standpipe between the stripper and the regenerator and another in the standpipe between the regenerator and the reactor.

It has now been found that this process, which may be used with excellent results on a technical scale, can be advantageously modified by carrying out the stripping operation in a stripper which is situated within the regenerator and which stripper communicates from a place near its bottom with the regenerator in order that stripped catalyst can flow from the stripping space directly to the adjacent regeneration space. When the pressure of the gas phase in the stripper is correctly chosen, the catalyst level in the stripper adjusts itself automatically so that a separate control of this catalyst level by means of a control valve is unnecessary.

Accordingly, the present invention provides a process of the kind hereinbefore described for the catalytic cracking of a hydrocarbon oil in which fluidised catalyst issuing from the reactor is passed to the stripper, which stripper and a regenerator, wherein catalyst issuing from the reactor is passed to the stripper, which stripper is situated within the regenerator and which stripper is near its bottom in direct communication with the regenerator, and wherein stripped catalyst is allowed to flow directly from the stripper to the regenerator via said communication.

Steam exemplifies suitable stripping agents which may be employed.

In the process of this invention wherein the catalyst issuing from the reactor is brought into the stripper via a riser by means of a stripping agent, stripping of the catalyst is thus effected in a stripper which is in direct contact with, for example which is built in, the regenerator. From the stripper the stripped catalyst, which is kept in a fluidised state, is passed directly into the bottom of the regenerator, that is to say without an intervening standpipe and without an intervening control valve.

The present invention is based on the discovery that a positive control of the catalyst stream between the stripper and the regenerator by means of a standpipe with a control valve, such as was hitherto considered of essential importance for safety reasons, in order to avoid the danger of oxygen-containing gas from the regenerator entering the reactor when the pressure in the regenerator suddenly increases, is entirely unnecessary. It has been found that, if as a result of a sudden increase of pressure in the regenerator, gas from the latter enters the reactor via the stripper, the oxygen content of this gas is so low that it presents no danger.

As in the process disclosed in the aforementioned Patent No. 718,578, the stripping operation which is applied to the catalyst in the process of this invention is very effective. The present process has the further advantage of being easier to carry out, since a separate control of the catalyst flow between the stripper and the regenerator is no longer necessary, and the required apparatus is of a more compact design so that a smaller ground area is sufficient. Furthermore, the cost of construction of the apparatus required is lower owing to the omission of the separate stripper and the supporting members required therefor, while at the same time the total height of the apparatus can be kept smaller as a result of the absence of a standpipe between the stripper and the regenerator.

This invention further provides novel apparatus suitable for carrying out a process of the kind hereinbefore described, which comprises a reactor provided with a supply line near the bottom for hydrocarbon oil to be cracked and finely divided catalyst and with a vapour discharge line near the top, a regenerator situated at about the same height as the reactor, in which regenerator is situated a space for stripping catalyst from the reactor, which stripping space communicates directly at a place near the bottom thereof with the regenerator (for example by one or more openings in the partition between the stripping space and the regenerator), and which stripping space is provided with a riser extending to above the normal catalyst level in the stripping space, to which riser is connected a standpipe for supplying catalyst from the reactor and supply means for gaseous stripping agent, the regenerator being provided near the bottom with conduit means for supplying regeneration gas thereto and near the top with gas discharge means and communicating with said hydrocarbon oil supply line via a standpipe fitted with a control valve for recycling regenerated catalyst to the reactor, the gas phase in the stripping space and that above the catalyst bed in the reactor being interconnected by a line fitted with a control valve.

The present invention is further illustrated with reference to the diagram of the accompanying drawing, which represents an apparatus for cracking hydrocarbon oils using fluidised catalyst. This apparatus comprises a reactor 1 and a regenerator 2 with a centrally built-in cylindrical stripper 3. The hydrocarbon oil to be cracked is passed into the reactor 1 through a line 4, together with regenerated catalyst which is drawn off from the regenerator via a standpipe 5 provided with a control valve 6. Spent catalyst flows from the fluidised catalyst bed, of which the level in the reactor 1 is at *a*, via a standpipe 7 into the riser 8 in which it is transported in a dispersed phase to the stripping space 3

by means of steam injected through a line 9. During this transport to the stripping space 3, the greater part of the evaporable hydrocarbons adsorbed and entrained by the catalyst particles are stripped off. The riser 8 extends above the level *b*, to which level the catalyst bed in the stripping space 3 adjusts itself, and the catalyst particles issuing from the top of this riser with the stripping gases fall into this bed, which is kept in a fluidised state by means of steam supplied at the bottom via lines not shown. The hydrocarbon vapours and steam are led from the top of the stripping space 3 via a cyclone 9' and a line 10 to the vapour space at the top of the reactor 1, from where they, together with the cracking products formed, are drawn off via cyclone 12 through a line 13. By means of a control valve 11 situated in line 10, the vapour pressure in the gaseous phase of the stripping space, and thus the catalyst level in the said space, can be kept constant in case the vapour pressure in the reactor becomes higher or lower.

Stripped catalyst flows continuously from the stripping space 3 directly into the surrounding regeneration space via the openings 14 in the bottom of the partition between the stripping and the regeneration space. Carbon deposits on the catalyst are burnt off in the regeneration space by means of oxygen-containing gas, for example air, which is supplied at a sufficient rate through the lines 15 and distributors 16 to keep the catalyst bed, of which the level is at *c*, in a fluidised state. Regenerated catalyst is recycled via the standpipe 5 and the supply line 4 to the reactor 1, while combustion gases leave the regenerator through the cyclones 17 and the line 18.

In the above-described apparatus the stripper is built in the regenerator and not only is more compact construction obtained but it is also ensured that a single slide valve viz. that in the standpipe 5, is sufficient in the entire catalyst re-cycling system for re-cycling regenerated catalyst to the reactor. This is due to the fact that owing to the direct transport of catalyst from the stripping space to the regeneration space, a standpipe with a slide valve between these spaces is no longer required. This is a considerable advantage since slide valves are expensive and have to be renewed after comparatively short operating periods on account of the severe erosion to which they are subject.

In the apparatus shown in the accompanying drawing the stripper is axially situated in the regenerator, so that the stripping space is laterally surrounded by the annular regeneration space. Although such a central arrangement of the stripper is usually preferred, it is not strictly necessary. Alternatively the stripper may be a segmental space defined, for example, by a part of the wall of the regenerator and by a partition which extends vertically through the regenerator and through its horizontal cross-section in the form of a chord.

What we claim is:

1. A process of the kind hereinbefore described for the catalytic cracking of a hydrocarbon oil in which fluidised catalyst is cycled through a reactor, a stripper and a generator, wherein catalyst issuing from the reactor is passed to the stripper, which stripper is situated within the regenerator and which stripper is near its bottom in direct communication with the regenerator, and wherein stripped catalyst is allowed to flow directly from the stripper to the regenerator via said communication.

2. A process as claimed in Claim 1, wherein the stripper is situated substantially coaxially within the regenerator.

3. A process as claimed in Claim 1 or 2, wherein the stripping agent is steam.

4. Processes for the catalytic cracking of hydrocarbon oils substantially as hereinbefore described with particular reference to the accompanying drawing.

5. Cracked products whenever prepared by a process claimed in any one of the preceding claims.

6. Apparatus for carrying out a process of the kind hereinbefore described, which comprises a reactor provided with a supply line near the bottom for hydrocarbon oil to be cracked and finely divided catalyst and with a vapour discharge line near the top, a regenerator situated at about the same height as the reactor, in which regenerator is situated a space for stripping catalyst which has been withdrawn from the reactor, which stripping space communicates directly at a place near the bottom thereof with the regenerator and which stripping space is provided with a riser extending to above the normal catalyst level in the stripping space, to which riser is connected a standpipe for supplying catalyst from the reactor and supply means for gaseous stripping agent, the regenerator being provided near the bottom with conduit means for supplying regeneration gas thereto and near the top with gas discharge means and a standpipe fitted with a control valve for recycling regenerated catalyst from the regenerator to the hydrocarbon supply line leading to the reactor, the gas phase in the stripping space and that above the catalyst bed in the reactor being interconnected by a line fitted with a control valve.

7. Apparatus as claimed in Claim 6, wherein the stripping space is situated substantially coaxially within the regenerator.

8. Apparatus for the catalytic cracking of hydrocarbon oils substantially as hereinbefore described with particular reference to the accompanying drawing.

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1 SHEET

This drawing is a reproduction of the Original on a reduced scale.